

CHEMICAL & ENGINEERING NEWS

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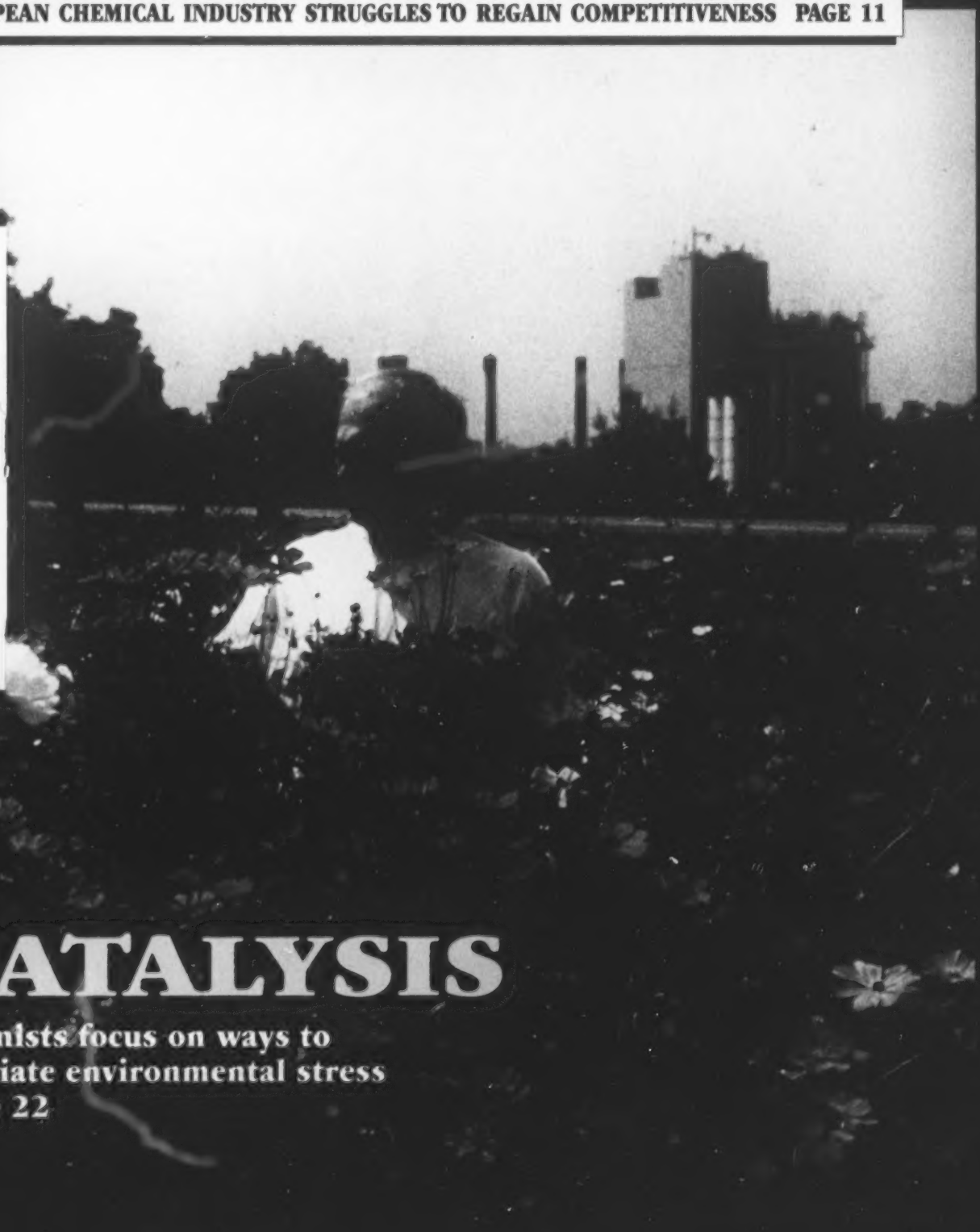
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Chemists focus on ways to
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CHEMICAL & ENGINEERING NEWS

C&EN

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LETTERS

Stereochemistry vocabulary

I am rarely in favor of inventing new terms to replace perfectly good old ones. But at the risk of violating this personal policy, I would like to offer some suggestions about several stereochemical terms that are sometimes misused, and get the reaction of interested C&EN readers.

The term *stereogenic center* is currently used to describe what was once called an asymmetric (or chiral) atom. I would like to propose a more meaningful definition of this and several related new terms. If we accept *stereogenic* as meaning "giving rise to stereoisomers," then a *stereogenic atom* can be defined as an atom where interchange of two of its substituents gives rise to a different stereoisomer of the original molecule. (This is essentially the definition given by G. E. McCasland, as cited by K. Mislow and J. Siegel [J. Am. Chem. Soc., **106**, 3319 (1984)].

Because stereoisomers are further subdivided into enantiomers and diastereomers, I suggest defining two types of stereogenic atoms—*enantiogenic* and *diastereogenic*. An *enantiogenic atom* is an atom where interchange of two of its substituents gives rise to the enantiomer of the original molecule, whereas a *diastereogenic atom* is an atom where interchange of two of its substituents gives rise to a different diastereomer of the original molecule. Clearly, the usual situation of a tetrahedral atom with four different substituents is an example of an enantiogenic atom. In molecules with multiple stereogenic atoms, for example, 2,3-dibromobutane, the bromine-bearing carbons would be diastereogenic atoms (not enantiogenic) because interchange of any pair of substituents on either atom would lead to a different diastereomer. Similarly, atoms that used to be described as "pseudo-asymmetric" would now be more accurately described as diastereogenic.

A *stereogenic center* (stereocenter) can next be defined as an atom or linkage (grouping) of atoms where interchange of two substituents at the atom or at one end of the linkage gives rise to a different stereoisomer of the original molecule. A stereogenic center can be either an *enantiogenic center* (enantiocenter, an atom or linkage of atoms where interchange of two substituents at one end of the linkage gives rise to the enantiomer of the original molecule) or a *diastereogenic center* (diastereocenter, an atom or linkage of atoms where interchange of two substituents at one end of the linkage gives rise to a different diastereomer of the original molecule). Thus, the term enantiocenter would

include a suitably substituted allene linkage, spirocyclic ring, nonrotating biphenyl system, or similar structural unit, as well as an enantiogenic atom. A suitably substituted carbon-carbon double bond (that is, where geometric isomers are possible) would be an example of a diastereocenter.

With these definitions in place, the maximum number of stereoisomers possible for a given structure equals the familiar 2^n , where n is the total number of stereocenters. (The actual number of stereoisomers would be less when the molecule is symmetrical.) Thus, 3-penten-2-ol has one enantiocenter (the OH-bearing carbon) and one diastereocenter (the double bond) and can exist in four stereoisomeric forms (two pairs of enantiomers): (*cis*-*R*), (*cis*-*S*), (*trans*-*R*), and (*trans*-*S*). On the other hand, 2,4-hexadiene has two diastereocenters (the double bonds), so it exists as four different diastereomers: (*cis*, *cis*), (*cis*, *trans*), (*trans*, *cis*), and (*trans*, *trans*). Molecules with two diastereogenic atoms (for example, 2-bromo-3-chlorobutane) would give rise to four stereoisomers (two pairs of enantiomers): (2*R*,3*S*), (2*S*,3*R*), (2*S*,3*S*), and (2*R*,3*R*). Note that the *R/S* configurational nomenclature system is applicable to enantiocenters as well as many diastereogenic atoms.

There has also been some confusion in the way the term *chiral* is used. The purest definition is "to possess handedness," that is, to be dissymmetric. We often define it further as "having an enantiomer (a nonsuperimposable mirror image)," or as "capable of existing as enantiomers." Is it then correct to say that 2-bromobutane is chiral? Or is it only the individual enantiomers of 2-bromobutane that are chiral? Certainly when we encounter "chiral reagents" we infer that they are enantiomerically pure or at least enantio-enriched. If "chiral" applies only to the enantiomers of 2-bromobutane, then what term describes the fact that 2-bromobutane is capable of existing in enantiomeric forms? I suggest that 2-bromobutane could be described as enantiogenic, that is, giving rise to enantiomers, and also as possessing one enantiogenic center. We can reserve the term *chiral* for specific structures that have a nonsuperimposable mirror image.

Roger S. Macomber
Department of Chemistry
University of Cincinnati

Correction

- Jan. 31, page 30: The headline of the chart and its horizontal axis should refer to weeks, not months.

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European Chemical Industry Struggles To Remain Competitive

■ **Governmental and social strictures are cutting into ability of European producers to compete globally**

Patricia L. Layman, C&EN London

Europe has discovered competitiveness—the need to be able to keep up with industries from around the world. Competitiveness has become the consuming topic of national governments and the European Union (EU), as the European Community is now known, in response to what is becoming clear: As the century moves to its close, European industries cannot compete effectively.

One of Europe's most successful industries—chemicals—is helping lead the fight to improve conditions promoting competitiveness. Its lobbying efforts are given weight by the fact that the industry is a solid contributor to the EU's balance of trade, still maintaining a trade surplus, while many other industries have slipped into a trade deficit.

However, the chemical industry is hampered by high unit labor costs, which represent 23% of output value, compared with 13% in the U.S. and 9% in Japan, as well as energy costs significantly higher than those in the U.S. and Middle Eastern countries. Spending on environmental protection now takes roughly 15% of capital spending in the German chemical industry, and nearly as much in the U.K., compared with about 10% in the U.S. and less than 5% in Japan. One of the few "lower" measures is hardly comforting—R&D spending by the European chemical industry is probably about 5% of sales, compared with roughly 6% of sales in the U.S. and nearly 6.5% in Japan.



Margetts: market position, technology are important for company survival

With specific areas of concern that leaders in the chemical and other industries have targeted, and with other, different areas acknowledged by many politicians, industry leaders and politicians are slowly moving toward a center ground. Finding the will and the way to accomplish effective goals for European competitiveness will be a difficult process, but efforts have begun.

Late last year, a report issued by UNICE, the Union of Industrial & Employers' Confederations of Europe, looked at "Making Europe More Competitive: Towards World-Class Performance." At about the same time, the European Round Table, a group of senior industrialists from throughout Europe, issued "Beating the Crisis." This report is an action plan designed, in part, to rebuild competitiveness for European industries.

Both were timed to coincide with the December release by the European Commission (the administrative arm of the EU) of the white paper by com-

mission president Jacques Delors on "Growth, Competitiveness, and Employment." The paper calls for specific growth targets for the economy and for the need for stability in economic and regulatory policies.

Two months before that, the European Chemical Industry Council (CEFIC) had presented to Delors and other commissioners its consultative paper "Focus on Competitiveness" as its contribution to the white paper. The white paper itself is considered by the European Commission as "an analysis of the situation and a starting point for action."

As CEFIC noted at the time, "As a major supplier to other industry sectors, and therefore a key contributor to overall economic growth, the European chemical industry proposes a series of measures to restore competitiveness and reverse the decline in Europe's position on the world scene."

Among other points, CEFIC emphasized the need for flexibility in labor markets, affected in part by a reduction in government-required compensation levels of all sorts. However, CEFIC noted, "It would be inappropriate to contemplate the compensation of a reduction of the labor costs by new taxes, such as the proposed carbon dioxide-energy tax, as this would not improve the competitiveness of industry. Energy prices in Europe are already 40% higher than in the U.S.A."

Competitiveness was one of the key themes of the U.K. Chemical Industries Association's (CIA) mid-January annual business outlook conference, cosponsored by CEFIC. For Clive Thompson, vice president of Arco Chemical Europe, Maidenhead, U.K., the conference provided the setting for considering how to mesh competitiveness with the laudable concept of sustainable development. As he pointed out, sustainable development "presupposes that the basic economy is healthy, and that society understands the trade-offs and sacrific-

es necessary to take on the sustainability commitment."

It is clear, he added, that the European economy is suffering from structural problems, and that "within the economy there are few bright signs of competitiveness in the different sectors of the chemical industry. There are those who point to the fact that we are at the bottom of both industry and economic cycles and, while this is true, we should not expect a normal economic recovery to solve our problems."

In the U.S., between 1974-91, some 70% of the working population was employed. In the EU, the proportion was 59%, he observed. In the U.S. during that period almost 30 million new jobs were created; in the EU, the number of new jobs created reached only 3.1 million.

"In our endeavors to protect employment, we have failed to create new jobs and through the high total cost of employment including salaries, short working weeks, and social costs, we are pricing ourselves out of work," Thompson said. Moreover, although the energy-intensive industries of Western Europe have long complained about high energy pricing, EU governments have traditionally used energy as a source of taxation. The result is that European industries face energy pricing that is not competitive with the U.S. and Middle Eastern countries and, although the region is the most energy efficient internationally, it faces another possible energy tax on carbon dioxide generation.

"Future legislation," Thompson concluded, "must only be considered where there are clear and quantifiable objectives. If applied, economic instruments should be well targeted and should be fiscally neutral. Above all, they should not distort competition."

For Rob Margetts, a director of ICI

and a CEFIC board member, there is also a "micro" dimension to the competitiveness problem—what each company can do for itself. As he contended at the CIA conference, only those chemical companies that can achieve and sustain international competitiveness will survive the increasingly tough next 10 years.

The key to corporate survival, he suggested, lies in a company's organizational "architecture." "The way a firm arranges all the pieces or building blocks within its organization is the key to international competitiveness," Margetts said. And among the most important building blocks for a chemical company are market position and technology.

Market position takes into account the firm's position in the lineup of international companies, not only globally and within the different regions of the world, but also in the different sectors of each product market. Not surprisingly, he observed, "with size and coverage, a firm can have important unit-cost advantages through economies of scale in a wide number of activities, including purchasing, manufacturing, distribution, and marketing."

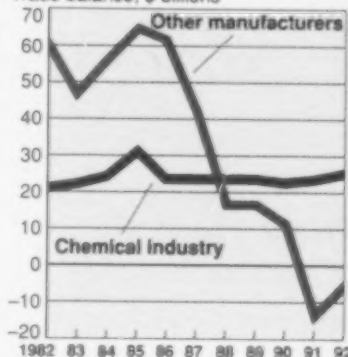
Market position can offer other potential competitive advantages, including spreading the costs of R&D across a number of markets. This improves the company's new product and process development capability and enables the firm to form partnerships with major customers.

Technology, he argued, is vital in supporting market position and cost competitiveness. He warned against various myths about the role of technology in achieving competitive advantage: "The most dangerous of these is the widely held belief that technological superiority is itself sufficient." To make technology work effectively, individual companies must turn it into tangible results in the market. Moreover, in the chemical industry, state-of-the-art technology is essential in terms of both products and processes.

The numerous points drawn out in papers and discussions at CIA's business outlook conference found reinforcement a week later at the annual start-of-the-year press conference of the Association of the German Chemical Industry (VCI), in Frankfurt. As VCI president Gert Becker, chairman of Degussa A.G., noted, "Economic recovery

Chemicals play strong role in EU trade balance

Trade balance, \$ billions^a



^a Constant dollars, year-end 1993.
Source: European Chemical Industry Council

alone will not solve our current problems [in Germany]. The global playing field has changed dramatically for our industry. Today, many products can no longer be produced in a competitive manner in Germany as a location. In many countries, the costs of feedstocks, labor, energy, and environmental protection, as well as taxes and social security contributions, are far lower than in Germany, and the quality of goods they produce is satisfactory."

Measures to reduce costs alone are not a suitable way of safeguarding the future, he said. Rather, the chemical industry in Germany can only be successful in the long term if it succeeds in putting innovative products on the market. And "innovations only help when they can be rapidly implemented," said Becker.

"We believe it is a major step forward that all the main parties have recognized that deregulation and the dismantling of bureaucratic obstacles are among the most important tasks in economic and research policies," Becker observed. "The German chemical industry is of the opinion that the promotion of fundamental research at universities and institutes, as well as the promotion of applied research and development technologies of the future, such as biotechnology and genetic engineering, are the right approaches." However, he continued, "companies must be free to make their decisions about research and development and to orient these decisions toward the needs of the market."

Power costs in Europe exceed costs in U.S.

Index (U.S. = 100)	Gas	Electricity
U.S.	100	100
Germany	156	163
Italy	156	122
U.K.	147	114
France	145	132
Netherlands	123	106

Source: Dow Chemical, Arco Chemical Europe

The return to a more competitive Germany, Becker suggested, will not be easy. "There are many different areas in which politicians are called on to safeguard and improve the performance of our national economy and the basis for our standard of living." These include, for example, dismantling some of the taxes that make it disadvantageous to invest in Germany compared with other countries; consolidating much of Germany's social legislation; and reducing the country's national debt. "We very much welcome the fact that politicians have begun to rethink their attitudes and that first steps in the right direction are being taken," he added.

That message has gotten through to the opposition political party, the Social Democrats, and to IG Chemie, the chemical workers' union, which has about 800,000 members. The two groups have published a joint plan that attempts to balance environmental demands with the preservation of jobs.

Some of the key recommendations of the plan are the simplification of environmental legislation, acceleration of planning procedures to speed introduction of "green" products, and a clear timetable for legislation on chemical wastes.

Much of the action by the governments of the various European countries, however, will be influenced by the policy now being devised by the European Commission, which was addressed in the white paper by Delors. The white paper was written to encourage the 12 member countries to increase capital spending in a drive to create 15 million jobs by the year 2000, thereby cutting current unemployment rates in half.

The paper contains three central messages: First, that the EU needs to get back on what the commission calls the "growth path": annual growth in the EU economy of at least 3% up to the year 2000, although "there will obviously be some transitional problems and a need to build up to a higher growth rate again." Some of the main criteria for such growth are a higher rate of investment—23 to 24% of gross national product, up from the current level of about 19%; an increase in savings; stability of macroeconomic policies; and attention to rebuilding confidence.

Second, the commission sees the

need for more jobs. "While still keeping our basic social security protection, the EU can use the economic growth to create more jobs, particularly by removing obstructions to mobility of labor and part-time work."

And third, the white paper cites the need for medium- and longer term measures to improve competitiveness, in part by making the best use of the single market; conducting R&D; carrying out education and training; encouraging small- and medium-sized businesses; adapting to new technologies; and investing in the trans-European networks [telecommunications, transport, energy, and the like] both within the EU and in Central and Eastern Europe as well.

The commission says that what the white paper actually proposes are measures "to create an environment more favorable to enterprise within the internal market, including an integrated program for small- and medium-sized enterprises." A strategic program for the internal market is being written separately, officials add, and will include measures such as reorienting public intervention toward growth markets; revising the mechanisms and criteria of public intervention to avoid conflict between industrial competitiveness and job creation; and promoting "immaterial" investment for research, training, and know-how.

Among the areas the commission specifically mentioned were biotechnology, "where the early use of research resources will make for greater synergy between chemical companies and the big potential users in the health

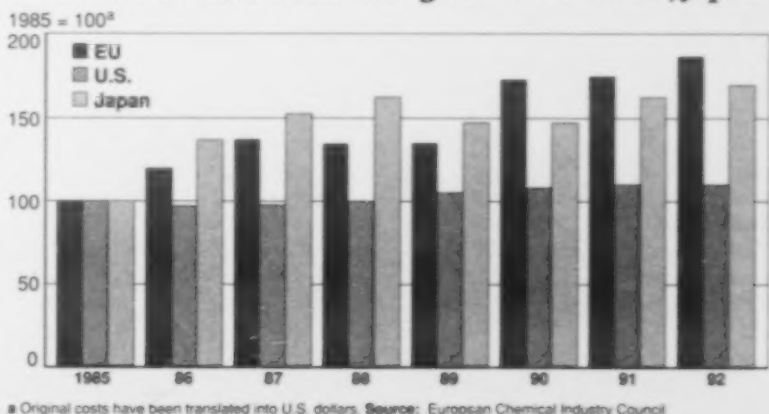
and agri-foodstuffs sector," and what it called ecotechnologies—"radical innovations targeting the causes of pollution and aiming at environmental efficiency through the production cycle. Ecotechnologies will soon provide a major competitive advantage."

The commission's comments on biotechnology, for one, struck a responsive chord among chemical companies in that field. Earlier, in October, the U.K. House of Lords' Select Committee on Science & Technology had issued a report on the regulation of the British biotechnology industry and global competitiveness. British industry greeted the report favorably.

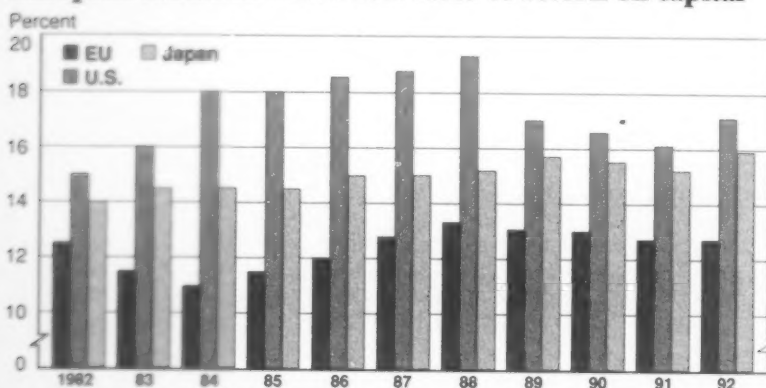
Typical of the response was the "wholehearted" welcome of the report by Peter Doyle, R&D director of life sciences company Zeneca. "The Lords have recognized not only the proven advantages provided by biotechnology, but also the extent of future benefits which the technology offers to mankind," he said. Moreover, implementing the findings in the report "will enhance the abilities of companies involved in biotechnology to be internationally competitive, by speeding up the approval of new products and reducing the cost of their development."

"The Lords recognize that a biotechnology product or process should be evaluated on its individual merits and not on the basis of the techniques by which it was developed or made. Zeneca agrees with the Lords that elements of the U.S. regulatory system, which undertakes evaluation on this basis, and which is also easy to understand, efficient, and cost-effective in its use of

Chemical unit labor costs have grown faster in EU, Japan



European business has lowest rates of return on capital



Note: Data are for all industry. Source: Union of Industrial & Employers' Confederations of Europe

the taxpayers' money, are to be applauded," Doyle added.

Comments on developing work such as biotechnology and ecotechnology from various governmental bodies, in particular, are bringing the competitiveness challenge into sharper focus. The efforts seem to be coming down to a drive by countries and companies to concentrate on technology and increasingly sophisticated R&D.

The Organization for Economic Cooperation & Development, for example, is preparing "a comprehensive strategy" to promote sustainable growth and employment for the 1990s, to be completed this year. One of the major topics addressed will be high-technology development. The plan calls for, among other things, the development and diffusion of technological change as the principal source of new skill-intensive jobs; competition, both national and international, spurring development of new technologies; and encouragement of private-sector enterprises, particularly new firms or transformed existing ones, to reap the benefits from new technological opportunities and create viable jobs.

Innovations in high-technology areas of chemistry should be sought, as should better understanding and acceptance of new techniques by both the authorities and the public, CEFIC argued in its consultative paper last October. Industry has the ability and capacity to innovate and to provide the best and least expensive solutions to solve present-day problems, provided, however, that industry is given enough time and freedom to develop these so-

lutions, CEFIC pointed out. And R&D and technological development should be fostered through academia, establishing a scientific infrastructure of global excellence.

Economic problems cannot be solved by the repeated addition of new taxes, added Hugo Lever, CEFIC's director general. Instead, the legislation jungle must be cut away, rather than be allowed to spread. That would improve profitability and help raise European industries' low rates of return on capital.

In CEFIC's analysis, erosion of competitiveness leads to a loss of market share in world exports, which in turn leads inevitably to declining economic growth—and increasing unemployment. The root cause of Europe's economic malaise is thus the erosion of the competitiveness of its manufacturing base. "This does not mean that Europe's economy in general is based on globally uncompetitive foundations, but it does mean that these foundations have been weakened over the years by governmental intervention that has either been inadequate, misdirected, or counterproductive," CEFIC said.

And CEFIC's chemical-industry-oriented analysis, in turn, tied in neatly with the more general recommendations of the European Round Table in its December paper on competitiveness. "What government can do," the paper stated, "is to enable industry to do its job, especially by action leading to the goals of lower costs, fewer regulations, and higher quality."

"Uncertainty is the enemy of investment, and it has been fueled by exchange rate instability, changing political

priorities, and unpredictable proposals on trade policy, competition policy, taxation, and energy costs. Governments should demonstrate their commitment to consistent economic policies that will generate confidence in Europe as a good place in which to invest."

Governments also have the task of cutting the level of their own waste, which eats away at the economy. "What is needed to reduce public spending is not public poverty but lean government based on value for money," the Round Table said. Its report concluded that Europe's political leaders need to do three things: commit themselves to a charter for industry, setting out a strategic approach to economic recovery and listing specific policy priorities; set up a European Competitiveness Council representing industry, government, and science, to advise on and monitor the detailed implementation of the charter; and put the charter into full effect through practical policy decisions to rebuild the competitiveness of Europe.

As VCI's Becker acknowledged, "Both political and industrial representatives will need to show courage and determination in the next few years in order to bring our country back onto a successful course." And although he was referring specifically in that statement to the chemical industry in Germany, his point can be extrapolated throughout the European chemical industry: "The chemical industry will do everything in its power to match [politicians'] efforts," Becker said. "We consider the crisis as an opportunity and are prepared to accept the challenge imposed by structural changes."

"The key to Europe's competitiveness is adaptability—by individuals and governments as well as firms," said Carlos Ferrer, president of UNICE, at the launch of that confederation's report. "Firms must be able to respond quickly to changes in the business environment. But they cannot do that if they are weighed down by the rigid legislative constraints and high-cost burdens prevalent throughout the community."

"Europe's lack of competitiveness is evident and the major concern now is that the future could be even bleaker. The pace and scale of change will increase, and threaten to leave Europe even further behind in the global trading competition in years to come, if action is not taken now," he added. □